The Signal Service Bureau. Its Methods and Results. By William Blasius.

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In 1872 the Leipzig Conference propounded this question, with others, to the principal meteorologists of the world: "Are you of the opinion that the present state of our knowledge of the weather justifies giving definite prophecies or predictions instead of the telegraphic communication of facts, or shall we limit ourselves to intimations upon the state of the atmosphere in the surrounding countries, from which the receivers of the communications may deduce their own rules?"

The replies were almost uniformly in the negative, and among them that of the very distinguished meteorologist, Prof. Buys-Ballot, of Utrecht, who said: "No prophecies, if we do not want to bring this matter into discredit. It is impossible for the director to say on which part of the coast the wind will blow first, and be the strongest, if he does not await the beginning of the storm at a place at some distance, and then it is too late. The state of the weather may be given. Every one may have the fixed rules by which, from this state, he may deduce his own results." And then, in a humorous way, he adds: "He who shall predict the weather, if he does it conscientiously and with inclination, will have no quiet life any more, and runs great risk of becoming crazy from nervousness."

The United States Signal Service Bureau has from the beginning—owing to the nature of its organization perhaps—taken a different course; it has devoted its chief efforts to *prediction* and *signaling*, while the study of nature and its laws has received but scant attention. And what is the result? Can it now give the "fixed rules," of which Buys-Ballot speaks, by which every one may be enabled to form some judgment of the weather? What additions to meteorological science has it ever made? Is there even one valuable result in all its voluminous literature that cannot be found in the prior works of others? If so, where and what is it? Nay, more. It has published during the last twenty years a vast conglomeration of facts and observations, at great expense of labor, intelligence and money, but from all this great material have any meteorologists the world over been able to make generalizations that have been accepted as sound and valuable?

I think, upon reflection, we must all see that the answer cannot be affirmative, and that when the results of the Signal Service Bureau's work are summed up, it is found to be utterly disproportionate to the means at its disposal, even in the matter of prediction. Its methods must therefore be at fault. Let us examine.

At the close of our civil war, upon the suggestion of the late Prof. Henry, the Telegraph Corps, whose services in the field as an active part of the army were no longer needed, was reorganized as the Signal Service Bureau, and its officers and soldiers became at one stroke, full-fledged meteorologists, but remained under strict army discipline, and worked under

rigid rules. The duties assigned to them individually were, however, and still are of a very simple nature. The "observers" at the various stations, at certain hours of the day, record in tabular columns the readings of their meteorological instruments, and telegraph these to Washington; and since my work on "Storms"* was published in 1875, in which I called especial attention to the Bureau's neglect of cloud forms, some simple observations upon the clouds are added to the telegraphic reports. Upon receipt of these reports at Washington, they are written down upon blank maps, on which the respective stations are marked. The points of lowest equal barometric pressure are then united by a line called the Isobar which usually form an ellipse. In the same way the stations of five or ten points of higher pressure are joined by a line. The field enclosed by these somewhat concentric Isobars is the "area of low pressure," or the "cyclonic storm" so called. From the results of the next reading the next position of the area of low pressure is ascertained in the same way, and by comparing the distance traveled with the time occupied, the probable position for some hours ahead is calculated, and predictions are issued. The labor is thus of a routine character.

"Areas of high barometer" are likewise noted, but these are thought to bring fair weather. The barometer therefore is still the chief reliance in the prediction of storms, and those storms which are distinguished as "areas of low pressure" are practically all that the Signal Service is able to predict.

Now, in the report of the Chief Signal Officer for 1884, there are noted as having occurred during the year 152 of these areas of low pressure, 172 tornadoes, 947 hailstorms, and 1745 thunder-storms, so that if every one of the 152 "cyclonic storms"—the "areas of low pressure"—are correctly predicted, we have some 2864 storms, of which the Bureau knew nothing until after they had occurred. Relying on the barometer and on machine methods, it could not be otherwise.

Lieut. J. P. Finley, Chief of the Tornado Division of the Bureau, in "Signal Service Notes, No. XII," says: "Probably if a barometer were placed in the immediate track of a tornado cloud, it would not with any certainty indicate the presence of the storm until the crushing winds had fallen on the instrument." Indeed, although the Bureau appears to proceed on the old rule that has obtained predominance since the days of Otto von Guericke, that a falling barometer denotes an approaching storm, it has long been well known that the most destructive storms often arrive with a rising barometer, and this for reasons that I explained as long ago as 1852. One of these storms took place at Colon, or Aspinwall, Panama, December 2, 1885. The New York *Herald* of December 18 says: "This storm was not preceded by any distinct precursory signs. The barometer on the Isthmus apparently remained stationary or slowly rose during the progress of the tempest. Much property, many vessels and lives were lost."

*STORMS: Their Nature, Classification and Laws. Porter & Coates, Philadelphia, 1875.

One of the most destructive storms this country has ever witnessed, occurred on the coasts of Nova Scotia and Newfoundland, August 23, 24 and 25, 1873, by which about 500 lives were lost and 1032 vessels destroyed, including 435 small fishing schooners. The Signal Service Bureau was entirely taken aback by this storm, because an "area of high pressure" or an "anti-cyclone" had been moving from Manitoba to the coast, and therefore, fair weather was to be expected. But in the weather maps for several days previous could be traced the gradual advance of a wave of cold air from the North—the "area of high pressure"—which banking up the warmer air in its front as shown by the gradually rising gradient, finally culminated in a terrific south-east storm with its centre of destruction on the coast. We thus have a storm of the most violent character traced on the maps of the Signal Service Bureau for several days as a fair weather indicator.

The Chief Signal Officer reports 80 "areas of high barometer" during 1884. Those occurring in the cold season mean fair weather, as they displace the warm current which has previously discharged its moisture. In the summer, however, this cool air from the North, which being heavy can be identified as an "area of high pressure," causes—in its displacement of the then prevailing warm and moist air—the south-east storm, with its tornadoes, hail-storms, cloud-bursts and thunder-storms, none of which the Signal Service Bureau predicts, and which cause vastly more destruction than the north-east storms—the "areas of low pressure"—both from their greater violence, and because they mostly occur at a season of the year when the work of the agriculturist is going on and his crops—on which the nation depends for its prosperity—are subject to injury.

It is true that quite lately the Bureau has turned its attention to this branch of the subject, after so many years of practical neglect, and that claims of considerable magnitude have been advanced as to what has been accomplished and what will be accomplished, both in the way of prediction and scientific discovery. Let us therefore examine into this a little.

The most eminent of American meteorologists—Redfield, Espy and others—agree in thinking the tornado the most instructive of all storms. It is in some respects the type of our American storms, since here the opposition of air-currents of different temperature and density, which is the general cause of storms, is most strikingly manifested and within the narrowest limits.

Mr. Wm. A. Eddy, an attaché of the Bureau, in *The Popular Science Monthly* for January, 1886, says: "During the first part of 1884, the United States Signal Service began to pay special attention to the question of tornado prediction. The development of the science was rapid under the active supervision of Lieutenant John P. Finley, having charge of that department of the service. It was found that the public interest in the question was widespread, and that with the aid of voluntary reporters of tornado phenomena, the possibility of saving life and property had begun to crystallize into a practical scheme." He further says: "During the

summer of 1886, it is hoped that, by means of signals, hundreds of lives and much valuable property will be saved."

The summer of 1886 has passed; can it be said that this hope is realized? Has the Signal Service saved a single life or any property by its tornado predictions?

Mr. Eddy tells us that the "invariable location south-east of the storm-centre is one of the main peculiarities of tornado development upon which the predictions depend." And yet to this same peculiarity, with its explanation, I called attention as early as 1852, and again in 1875, in the publication of my work on storms already referred to, and I urged it on the Signal Service Bureau during a personal visit to Washington at that time.

Mr. Eddy also says: "When the conditions are unfavorable for the development of tornadoes, there are no unusual contrasts of temperature, the areas of warm and cold air neither great nor well defined northward and southward, the winds are variable and not very strong, and the distribution of pressure is about normal." All this can be found in my work on "Storms," published in 1875—why is it put forward as a new discovery in 1886?

Indeed, it was only after the publication of that work that the Signal Service Bureau began to note the difference of temperature in air-currents—to which I had called attention—and made various and important changes in its method of prediction. But when Lieutenant Finley puts forth as a discovery of his own, the fact that tornadoes are caused by "two opposing air-currents of different temperatures and moisture," it seems a little singular, in view of my communication of the same fact to the Academy of Science in Boston, in 1851, its publication in 1852, and again, in 1875.

As to the prediction of tornadoes by the Signal Service, it can never be done with any certainty, except in so general a way as to be valueless. If any one has mastered the principles of atmospheric disturbance—and they are not so difficult—he will be able to judge for himself as to the probability of tornadoes being imminent in his locality ten times as well as the Signal Service can ever tell him. Just where the tornado will strike, and its path is a narrow one, no man can tell until within a few minutes of its passage.

Mr. Eddy says: "That during 1884, 3228 predictions *un*favorable to tornadoes were made, and of these 3201 were verified." But what a simple matter it is with the most ordinary knowledge and circumspection to say that tornadoes will *not* take place, when the dark clouds of the south-east storm give ample notice when there is a possibility of their happening? If we have a south-east storm we may or may not have tornadoes; but if we have *not* a south-east storm, then we have no tornadoes.

As to the prediction of a tornado itself, Mr. Eddy cites that which passed over Camden and Philadelphia, August 3, 1885, as "one of the best illustrations of the advance made in definiteness in predictions;" and he further says: "The chart used by Lieutenant Finley shows that tornadoes were predicted and their location marked upon the map for the State

of Delaware, South-eastern Pennsylvania and for New Jersey. The tornadoes actually occurred in these States, about eight hours from the time of prediction."

Now if we ask how valuable to the owners of the houses damaged by that tornado in Philadelphia was the Signal Service's prediction eight hours before, that tornadoes would occur somewhere in "Delaware, South-eastern Pennsylvania or New Jersey," we cannot fail to see, I think, the entire impracticability of the whole scheme.

The Signal Service is perhaps obliged by circumstances to devote most attention to those things which will show most apparent results to the general public and to Congressmen who vote for the annual appropriation. It is hampered too by its routine methods and its army rigidity of discipline. It cannot however but be a cause of disappointment that whether owing to these causes or others, it has added so little of scientific value to the knowledge of meteorology during the twenty years of its existence. It has been following the old methods in reference to which Sir William Herschel says: "In endeavoring to interpret the weather, we are in the position of a man who hears, at intervals, a few fragments of a long history, related in a prosy, unmethodical manner; a host of circumstances omitted or forgotten, and the want of connection between the parts prevents the hearer from obtaining possession of the entire story." And the great Biot, after enumerating the efforts to advance this science, says: "What has come of it? Nothing, and nothing will ever come of it. No single branch of science has ever been fruitfully explored in this way."

No, the methods followed have been wrong. Would astronomy be in its present position if the great astronomers had been dependent on the data furnished by observations made according to arbitrary rules, and for a minimum of time at one or two hours of the night, and for the most part, too, by observers of meagre training and intelligence? And how much would the great naturalists have learned, had they been content to send out into the fields three times a day for five minutes, and sit in their closets to generalize upon the data thus obtained?

Thirty-five years ago, I urged that only by *continuous* observations could we hope for anything beyond mere empirical knowledge; that we must gather up the "host of circumstances" now "omitted or forgotten," and supply "the connection between the parts." I am not unmindful of the practical difficulties that are in the way of a method of observation that alone can give a continuous knowledge of a storm as it passes; but it seems to me that this may be obtained with the means now available, if the meteorological organization would devote more attention to the discovery of general laws than to the more sensational part of their duties—the weather predictions, which the newspapers now make a matter of business enterprise. If we know the laws, there will be little trouble about the prediction. Each of us can do this for himself sufficiently well for all practical purposes.